

## A Method Proposal for the Preservation and Widespread Use of Mud Brick



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### ABSTRACT

Global warming, which is one of today's problems, and in this context, the effects of the use of materials that have high carbon emissions, contain chemicals, consume more energy in the production process, and tend to pollute the nature have begun to be discussed in detail in the world. Mud brick material is an important material due to its features such as shapeability with low labor force by taking materials directly from nature, drying with natural methods and not being waste in the nature after disposed. The mud brick material is defined by the Turkish Language Association [1] as “primitive brick, a mixture of straw and mud, which is poured into molds and dried in the sun for use in building walls”. One of the most basic materials of rural architecture in Anatolian lands, mud brick should be preserved and transferred to the future with its values. Transferring mudbrick material to the future, learning it, and combining it with new and contemporary technologies will enable to obtain a material that will respond to the fundamental problems of the world. However, the most basic way of preserving mud brick material is to preserve the areas where it is used. The mud brick, which is used extensively in rural areas, is on the verge of disappearing as these areas tend to disappear in Anatolian lands. This study is based on the hypothesis that rural areas must be preserved in order to preserve mudbrick material and transfer it to the future. And it aims to develop proposals for the preservation of rural areas. When Development Plans and National Rural Development Strategies prepared by the relevant institutions of the Republic of Turkey [2–10] is examined. It is seen that it is aimed to take various measures to maintain rural areas. However, it is seen that the population in rural areas decreased rapidly in the period from 1927 to 2020. The decline of 10% in the rural population between the years 1927-1960 to the situation where only 6% of the population of Turkey lived in rural areas in the 2000s [2,9,11] shows us that the population in rural areas cannot be preserved, therefore rural areas cannot be preserved either. The most basic condition for the preservation of rural areas is the protection of the local people and their survival. Bektas [12] draws attention to the act of protection that cannot be carried out by freezing the past and creating uninhabitable cities for the people of the age. In addition, he draws attention to the fact that areas which do not catch up with the era and do not respond to new needs will disappear on their own. It is emphasized that preservation can only be made by ensuring that the existing user stays in the city. In this context, this study aims to examine the Rural Area Design Guides, which first protect the users of rural areas, then directly ensure the preservation of rural areas, and will ensure the preservation and transfer of mudbrick material to the future.

**Keywords:** Mud Brick, Village Design Statements, Rural Architecture

## **1 THE USE OF MUD-BRICK AS A BUILDING MATERIAL, ADVANTAGES AND DISADVANTAGES**

Mud brick is one of the oldest building materials that has been used in the world and in Anatolia since ancient times. It continues to exist as the most basic building material of traditional buildings, especially in rural architecture, in Anatolia [13]. The "mud brick" as a building material is an important part of our cultural heritage in Anatolia in the formation of the anonymous building group which is called "vernacular architecture" or "rural architecture in which its master is unknown, a public domain.

Today, due to the increase in environmental pollution and the global warming problem, which has arisen with effects such as the crises in the energy field, it has become important to reuse or widespread the use of "natural" building materials that do not harm the nature, that are recyclable and that do not emit carbon. At this point, it is important to preserve mudbrick, in order to examine its properties and to create possibilities for use due to its naturalness as a traditional building material and its being representative of the vernacular rural architecture, and its performance advantages.

The reason why the use of adobe in buildings is advantageous is that it is a healthy material as well as it is low cost and easily available and it has a simple production process with its raw materials. The heat and sound insulation of the building material and its fire resistance are important factors. According to DIN 4102 and DIN 18951, mudbrick building material does not burn, it is non-flammable, does not emit smoke and odor unless there is a flammable additive in it. It is sound-retaining and impermeable according to its material properties. Since its structure is porous, it takes moisture. It provides a good bioclimatic comfort in all seasons [14].

Properties of mudbrick material can be listed as follows:

- Due to the porous structure of the dough and its ability to retain heat well, it absorbs moisture from the air and keeps the indoor temperature and humidity in balance, creating a clean and healthy environment.
- Soil, which is one of the best energy-storing materials after water, collects the heating energy when it forms the walls surrounding the building as a building material. Thus, it protects the building from the unwanted hot or cold air outside.
- No facility is required for its production and its cost is low. No mechanical energy is needed during its production or use. It can be expressed as one of the sustainable building materials because it requires less energy during its demolition compared to other building materials and is an environmentally friendly material [15].

In addition to the positive aspects of the adobe structure, there are also negative features. Some of these are low compressive strength, high sensitivity to water, needing regular and continuous maintenance.

### **1.1 Mud-Brick Construction Systems**

It is a material obtained by kneading clay and suitable soil with water, and sometimes adding some additives such as straw and vegetable fibers. Soil, which is the main material of mudbrick consists of clay, silt, sand and gravel according to their grain size. While clay acts as a binder, sand grains in the soil act as an endoskeleton.

For the improvement of mudbrick in Anatolia, straw is usually added to the adobe soil as an additive. The mud brick obtained from a mixture of soil and straw does not show high strength

values. Lime, blast furnace slag, cement, asphalt, plaster, and similar materials added to the adobe mortar improve the properties of mudbrick.

The mudbricks obtained in this way are called "improved mudbrick". Improved mudbrick obtained with additional additives has higher strength than traditional mudbrick.

There are three main ways to improve mudbrick.

- Mechanical improvement: Improving the density, mechanical properties and porosity structure of the soil by compaction.
- Physical Improvement: Improving the properties of the soil with different methods such as heating and drying.
- Chemical Improvement: It is the improvement made by adding additional additives to the soil.

Since mudbrick is homogeneous and compact, it is structural. Therefore, it can be used as a load-bearing wall material. When it gets wet, its structural property decreases. Depending on the type and amount of additives added into it, the strength of the material changes. It is resistant to bending, impact and abrasion.

The mudbrick construction systems in which traditional mudbrick materials have been used from past to present are basically divided into two as 'masonry mudbrick construction systems' and 'filled mudbrick construction systems between the post and lintel system'. In the masonry system, the walls built with mudbrick blocks act as structural material, while in the filled adobe system between the post and lintel system, timber posts and lintels placed inside the walls at regular intervals are structural material and mudbrick is used as filling material.

Mudbrick masonry systems are systems in which there are no timber structural materials between mudbrick materials, and mudbrick blocks are placed on top of each other. These systems are more commonly seen in flat-roofed and low-rise buildings in rural settlements in Anatolia [16].

In the wooden lintel mudbrick masonry system, the ground floors are generally built with masonry stone walls up to the height of the basement. After the basement level, mudbrick materials are used. Timber is used as a lintel on the window and door openings and as a horizontal beam along the floors (15). Horizontal timber lintels pass through the upper and lower parts of the door and window openings and continue along the wall. According to the earthquake risk in the region, these lintels were also used at more frequent intervals inside the walls [16].

Today, mudbrick continues to be developed with different quality additives added to its mortar in order to popularize the use of mudbrick and to increase its strength.

## **2 MUD BRICK MATERIALS IN TURKEY**

Mud brick was used instead of brick for the first time BC. as a building material in the Mesopotamian lands, where the stone was powered around 2500 BC. Mesopotamian lands, where the Assyrians built masonry with mudbrick material 6000 years ago, were also under the dominance of this material at that time [17–19]. Like all cultures settled in Anatolia from the Neolithic Period to the present, the Hittites used mainly mud brick materials in their structures. Wall remains made of mud bricks were found during the excavations. There is use of mudbrick material on the foundations made of crushed stones, but generally it has either completely disappeared, or the bottom part has been preserved. The remains that were exposed for a long time also created a disadvantage [20]. Especially in the Eastern Anatolia region, where the winter seasons are harsh, the use of stone and adobe materials is common. Among the reasons why it is common in this region are other construction materials such as wood are scarce and/or expensive,

and the adobe construction method is a material and construction method that has been used for a long time [17].

In the Anatolian geography, mud brick is mostly used as the main building material in the Central Anatolian Region. However, it is common in other regions to use it together with stone and wood. While mud brick material is mostly used in masonry system, mud brick filling between timber post, lintel systems and mixed systems where both are used together [21], it is also used as plaster, mortar, and filling material.

The mud brick material can contain the unique materials of each region and the structural changes according to the properties of those materials. The regional changes are shaped by the knowledge of the person performing the construction work. In Turkish Standard 2514 [22], mud brick is a material that can be used in construction by mixing straw or other vegetable fibers, etc. or other additives with suitable soil and clay and in order to be shaped and dried in the open air by pouring into molds after kneading them with water. Straw and other herbal materials used in the definition are the materials added to the mortar to prevent the adobe from cracking, and other vegetable materials defined as similar substances are reed type, coarse grass, hemp fibers, straw, waste straw collected from barn mangers, dry heather, pine needles, tree branches, saw and grater shavings [22]. It is possible to count lime and gypsum among other materials that can be added to the mud brick material. Lime affects the interaction of mud brick with water rather than its strength, and by this way adobe material that is more difficult to be affected by water is obtained [17]. The use of plaster in adobe material ensures that the material becomes more durable, less sensitive to water and moisture, and does not produce dust and dirt. During production molding and drying becomes more easy and cracking is reduced during drying [23].

As mentioned above, mud brick is a building material that is produced by various methods and techniques in Turkey and is mostly encountered in traditional architecture. Although academic studies have been developed on how to transform existing disadvantages along with its advantages, its contemporary use is not seen and cannot become widespread. Kafescioğlu states that there was a break in this sense in the 1950s. Anatolia is the cradle of the earthen structures, that the earthen structuring was left behind after the bricks, but during the World War II, there was a return to the land, and in 1948, a study on the development of soil structure in Turkey at the Anatolian level, under the leadership of Mustafa Inan, with a team from Istanbul Technical University, including himself, started, and that study was started in Turkey with the aim of creating a database. In addition, the details of the mudbrick material were learned by meeting with local craftsmen at the same time, and that the materials were examined and documented in laboratories by Bekir Postacıoğlu and Vahit Kumbasar. These studies, which lasted until 1950, were shelved together with the changing administration's statement "It is not befitting for a developing Turkey to deal with land" [24].

### **3 VILLAGE DESIGN STATEMENT AS A METHOD RECOMMENDED FOR THE CONSERVATION AND SUSTAINABILITY OF MUDBRICK IN TURKEY**

Village design statements ensure that the characteristics of rural areas that are worth preserving are maintained in today's conditions, and that they are transferred to the future with their original texture and identity. They are important because of their values below.

- It provides the context for a new development based on the local character and meaning of the settlement.
- It helps to manage change from the upper scale to the lower scale, regardless of whether the improvement will occur or not.
- It leads to the realization of a development plan in harmony with the values and characteristics of the settlement.
- It is prepared for the purpose of documenting and protecting the traditional identity of the city and making a positive contribution to the local environment.

- Along with interacting with the relevant legal regulations, it is specially prepared for each rural area [25].

It is aimed to define the social, cultural and spatial character of the village and to present methods and recommendations for its preservation [26]. With the rural design guides, it is tried to create a tool that can provide input to the official planning systems in order to increase the quality of new developments in rural areas and manage the physical change in the settlements by the users having their own design guides [27].

Village design statements, which started to be prepared intensively in England in 1993, also found their place in the Turkish Zoning Law in 2013. With the article added in 2013 to the Zoning Law No. 3194 prepared in 1985, it is aimed to promote the use of village design statements in Turkey as a method that will contribute to rural protection, sustainability and development.

When the various village design statements prepared until today are examined, the following headings draw attention [17,26,28–40].

- Determining the aims and objectives of village design statements.
- Introducing other legal regulations related to the statements.
- Researching the geographical and historical values of the villages.
- Determining the current situation in terms of local people, economy and future possibilities.
- Evaluation of the resources of the village such as tourism and mining.
- Revealing the interaction of the surrounding settlements with the silhouette and the selected region.
- Determining the relations between the surrounding settlements and the village border.
- Listing of village and special environmental values such as antiquities, woodland or natural resources.
- To reveal the characteristic features of the settlement such as special regions, layers, roads and routes, open space texture, relations with other settlements, relations between structures and spaces.
- Determining the characteristics of buildings in villages such as building typology, height, scale, density, size, style and typology, borders, walls and separations.
- Research of construction systems and materials.
- Determination of transportation conditions, possibilities and impossibilities.

As can be understood from the above-mentioned titles, the village design statements provide all the information, documents, field researches and their results to be revealed, and one of these titles are construction technologies and materials.

In the village design statement prepared for the villages of Balıkesir in 2011, the use of mudbrick is given in detail under the title of building materials. It was emphasized that the use of mudbrick in the villages of Balıkesir dates back to ancient times and that it continues to be used in some villages. Especially in hillside and plain villages, some of the old houses are mostly mudbrick. The ground floor or the first 1, 1.5 meters of the houses were built using stone, and the first floor or later was built using mudbrick. The dimensions of the mudbrick blocks used are similar and are 30/33X11, 5/15X12/14 cm. [31].

After giving general information on the use of mudbrick in Turkey in the village design statement prepared for the countryside of Kayseri in 2011, it was pointed out that mudbrick was mostly used as a joint mortar in plaster and stone masonry in the region, and that the mudbrick building tradition left its place to tuff in the following periods. In addition, while the materials used in the building inventories were determined in detail, mudbrick was also included. In the project reports prepared for the statement, the materials available in the region, their properties, their chemical,

physical, petrographic, mechanical, pozzolanic analyzes in the laboratory settings and their properties are given in detail [17].

In the Küre Ersizler Village Design Statement published in 2015, it was stated that wood, which is easy to find and easy to work in traditional buildings, is the primary building material in the researches on the rural architectural character of the Black Sea Region. An important reason why wood is preferred over materials such as stone, mudbrick and brick is that it has a better insulation value for moisture and heat transfers. And it has been emphasized that the use of mudbrick is not very intense in the region [26].

In 2015, in the village design statement prepared for the villages located within the borders of Küre Mountains National Park and connected to Bartın Province, a documentation study was carried out on the use of mudbrick as a material in the architectural texture analyzes made in some villages, and mostly included in the inventory slips [32].

When the village design statements published in Turkey are examined, it is determined that researches have been made on the regions where mudbricks are used, their usage styles and their construction methods. However, no attempt has been made to encourage its reuse. Or it is observed that no proposal has been developed for the reuse of mudbrick in new structures to be built to meet new needs.

Researches show that mudbrick has advantages that should be evaluated especially in today's world, which is getting more and more polluted by human beings every day. Its porous and heat-preserving structure makes it a material that keeps the heat and humidity in balance by absorbing the moisture in the air, creates a clean healthy indoor environment, and protects the building from the unwanted hot and cold air outside. It is an ecological and sustainable material due to its low production cost, natural structure, low energy requirement for its production, its ability to be produced in every region, pollution prevention and its low transportation cost, and recycling possibility. There are various researches on the solution of contemporary usage problems of the material, which has disadvantages as well as advantages. The main thing is to ensure the sustainability of the mudbrick produced with local materials, again through local materials. In this context, one of the solution proposals we come across is village design statements. Village design statements are guides that focus on a single rural area or region and also examine the area in terms of construction systems and building materials. Detailed reports of other available materials in the region are presented in the guide prepared for various regions. Detailed studies on the use of mudbrick in various regions have been found. However, no data were found in the statements on the use of mudbrick in new buildings to be designed in villages, in a way that would meet contemporary needs. However, one of the aim of village design statements is to preserve the traditional identity of the area and to reveal a development plan and method in harmony with the values and characteristics of the area beyond documentation.

In this context, the following titles are suggested for the dissemination of mudbrick for the preparation of rural design guides.

- Materials research: Investigation of natural materials in the region. Determination of chemical, physical and other properties by tests performed in laboratory environments.
- Documentation of the current situation: Determining the mudbricks prepared with traditional methods, investigating their construction and use. Determination of properties by tests carried out in laboratory environments. Determining the advantages and disadvantages that may arise when it comes to reuse in today's conditions.
- Experimental studies: Conducting studies and experiments on the materials discovered and researched in the region and the use of existing mudbricks in order to eliminate the disadvantages of their properties.

- Production and application areas: Testing the obtained material, revealing the methods for the dissemination of production and determining the application areas.
- Publication of the results: In line with the data obtained, publishing and disseminating the results regarding the improved mudbrick that can be used in the studied region, which is adapted to the requirements of the age, disadvantages have been eliminated as much as possible and supported by using local materials.

## **4 RESULTS**

The research shows that village design statements can be a good tool for documenting, protecting, and maintaining villages and makes it possible to document the materials and construction techniques used as well. However, although there are researches on construction systems and materials in village design statements, there are very few studies on its use and development in today's conditions.

On the other hand, mudbrick is a material that is widely used in rural areas and creates a cultural heritage value in Anatolian lands. Although there are regional differences in the components and proportions in its content, it is quite advantageous in terms of being ecological, sustainable and natural. It is possible to ensure its sustainability with the studies carried out and / or to be carried out on its contemporary use. Village design statements can be an important resource for the maintenance of mudbrick.

When the researches to be carried out in areas where mud brick is used in rural design guides are handled in line with the above-mentioned titles, it is possible to create a good resource for learning and reusing the material. In order to implement the suggestions developed in this context, it is recommended to cooperate with the relevant institutions, organizations and individuals and to continue the studies by going beyond the documentation work in the preparation of rural design guides.

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